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# United States Patent [19]

**Antonelli**

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[45] **Date of Patent: Jun. 30, 1998**

[54] **SOLENOID APPARATUS HAVING A PLUNGER WITH AN INTERNAL PASSAGE AND A VACUUM SOURCE FOR GENERATING NEGATIVE PRESSURE**

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[73] Assignee: **Pitney Bowes Inc.**, Stamford, Conn.

[21] Appl. No.: **705,506**

[22] Filed: **Aug. 29, 1996**

**Related U.S. Application Data**

[62] Division of Ser. No. 498,007, Jul. 3, 1995, Pat. No. 5,581, 972.

[51] **Int. Cl.**[6] ..... **H01F 1/00**

[52] **U.S. Cl.** ..... **335/219**; 335/239; 335/240; 335/255; 335/260; 335/261

[58] **Field of Search** ..... 335/219, 239, 335/240, 255, 260, 261; 251/129.22; 414/627

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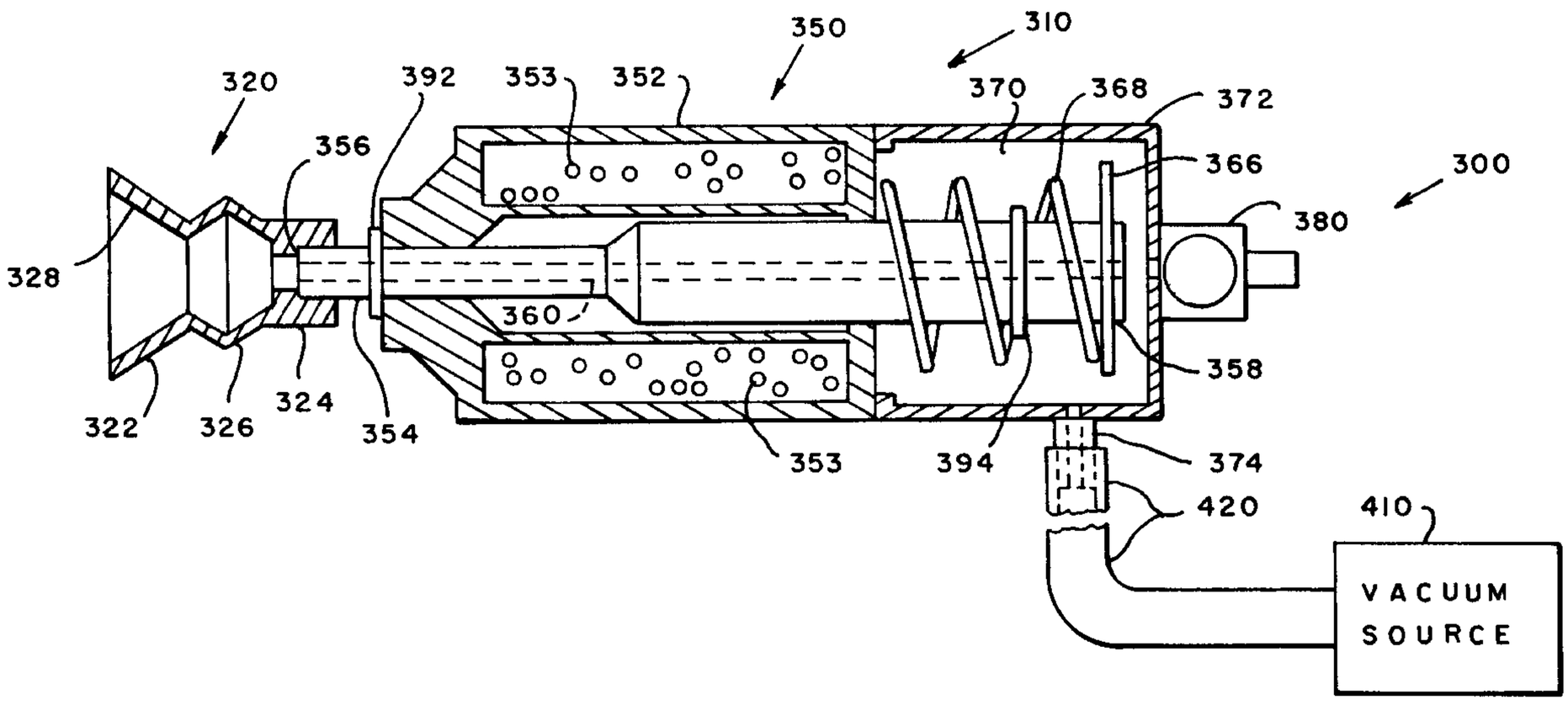
*Assistant Examiner*—Raymond Barrera
*Attorney, Agent, or Firm*—Angelo N. Chaclas; Melvin J. Scolnick

[57] **ABSTRACT**

Solenoid apparatus having a substantially cylindrical casing, an electro-magnetic coil, a plunger axially aligned and slideably mounted to the casing, a housing hermetically mounted to an end of the casing and a vacuum source operatively coupled to the external port. The plunger has a first end extending outside of the casing, a second end and an internal passage extending from the first end to the second end. The electro-magnetic coil is selectively energizeable for moving the plunger between a first position and a second position. The housing corresponds to the plunger second end to define an inner chamber which encloses the plunger second end. The housing includes an external port connected to the inner chamber so as to provide an unobstructed pathway from the external port to the first end of the plunger via the internal passage and the inner chamber regardless of whether the plunger is in the first position, the second position or therebetween. The vacuum source is selectively activatable for generating negative pressure at the first end of the plunger via the inner chamber and the internal passage.

**4 Claims, 9 Drawing Sheets**



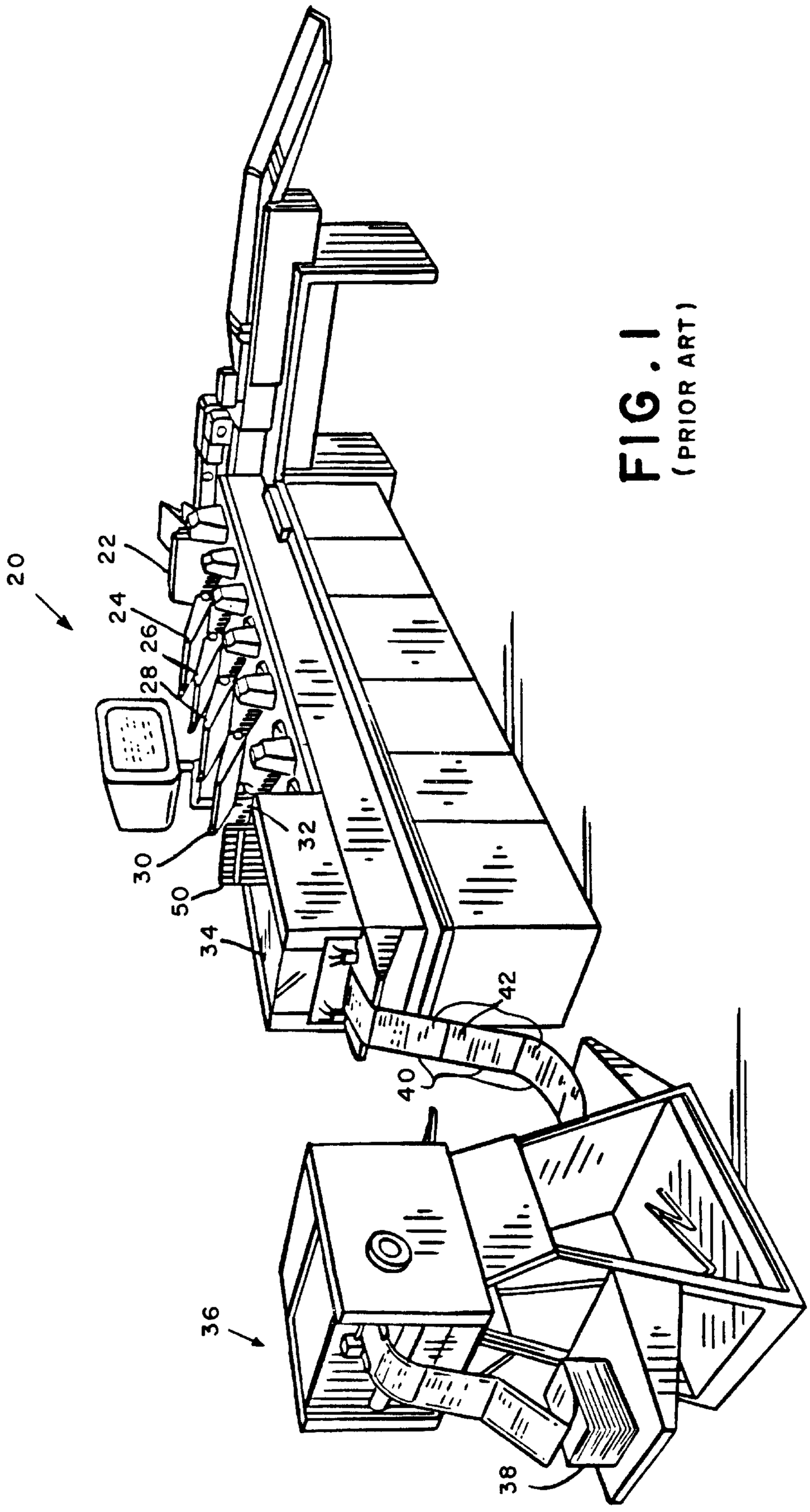



FIG. 1
(PRIOR ART)

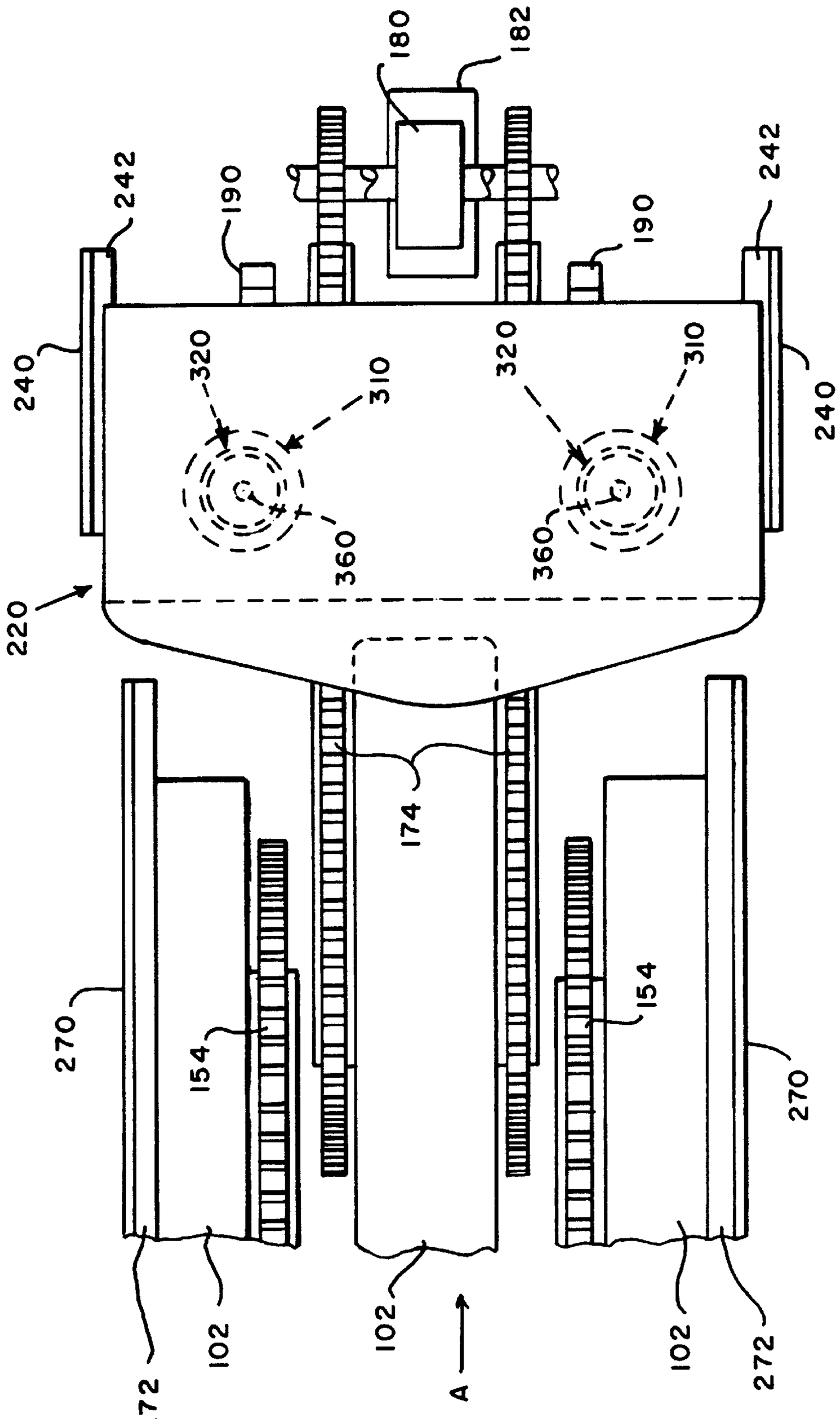

180
182
242
190
190
242
240
320
310
320
310
240
360
360
220
174
270
154
154
270
102
102
102
272
272
A

FIG. 2

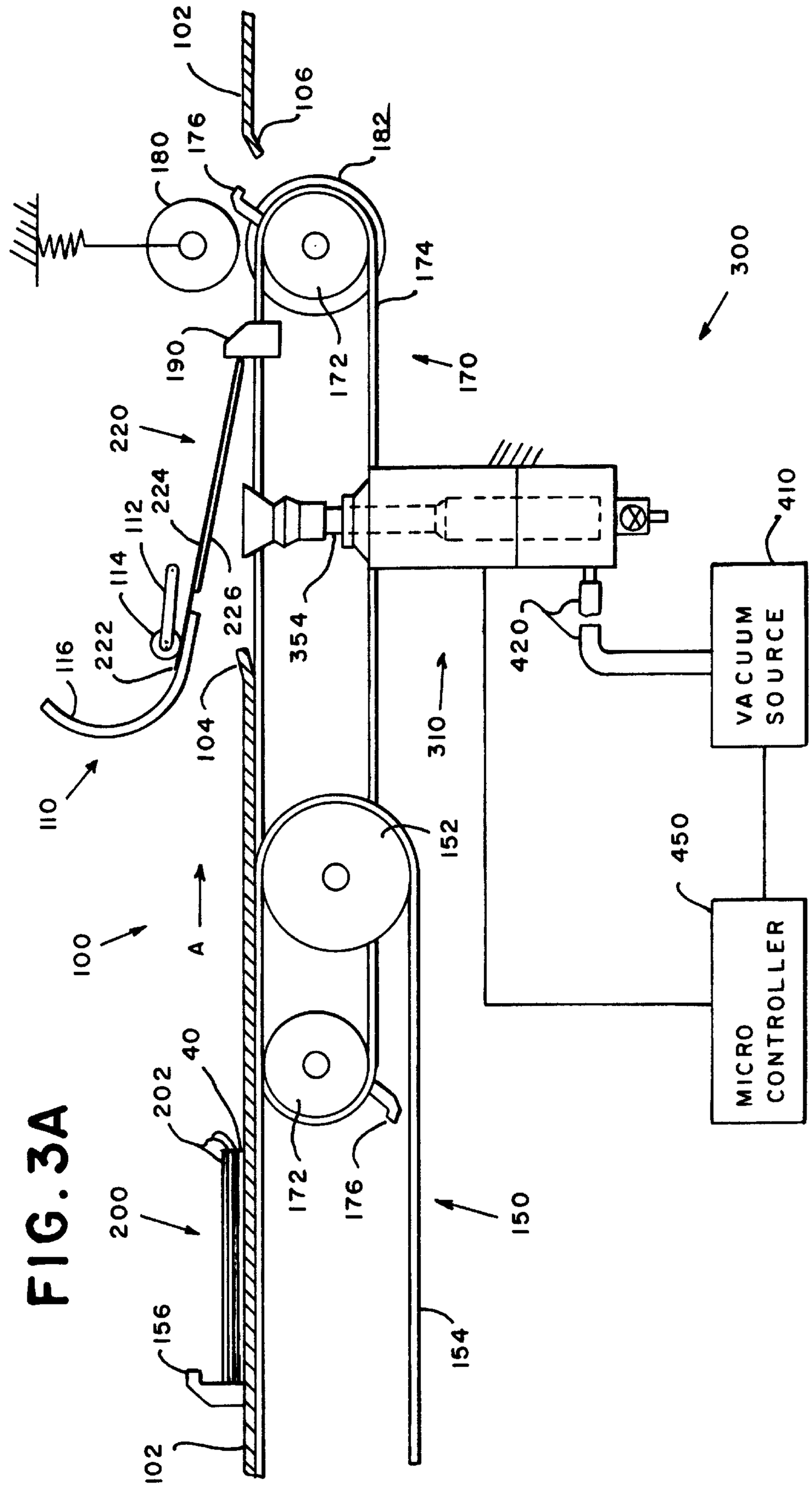

102
106
180
176
182
174
190
172
170
300
220
224
112
114
222
116
226
354
420
410
VACUUM SOURCE
104
310
110
152
450
MICRO CONTROLLER
100
A
202
40
200
172
176
150
156
154
102

FIG. 3A

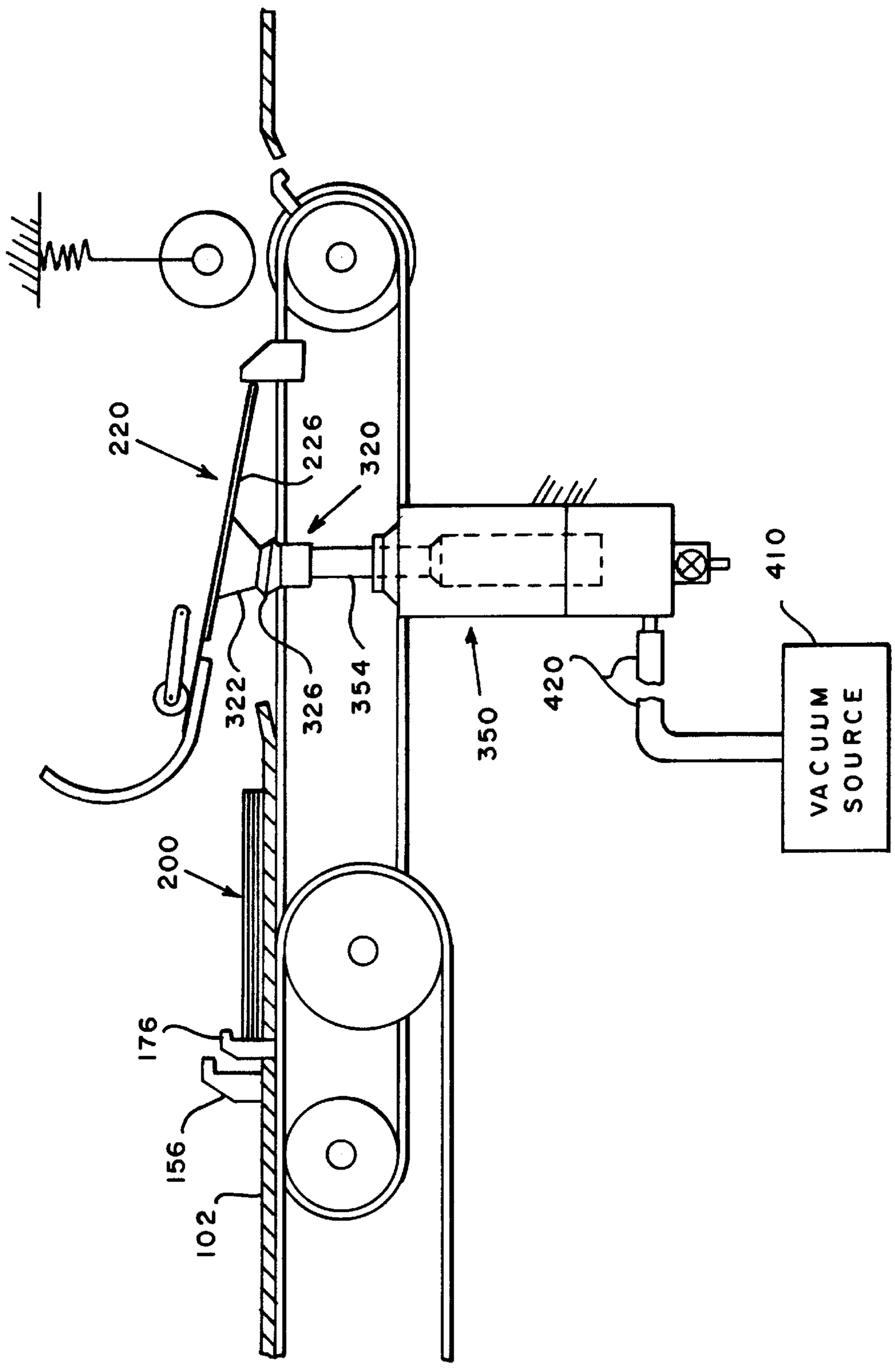

220
226
320
322
326
354
350
420
410
VACUUM SOURCE
200
176
156
102

FIG. 3B

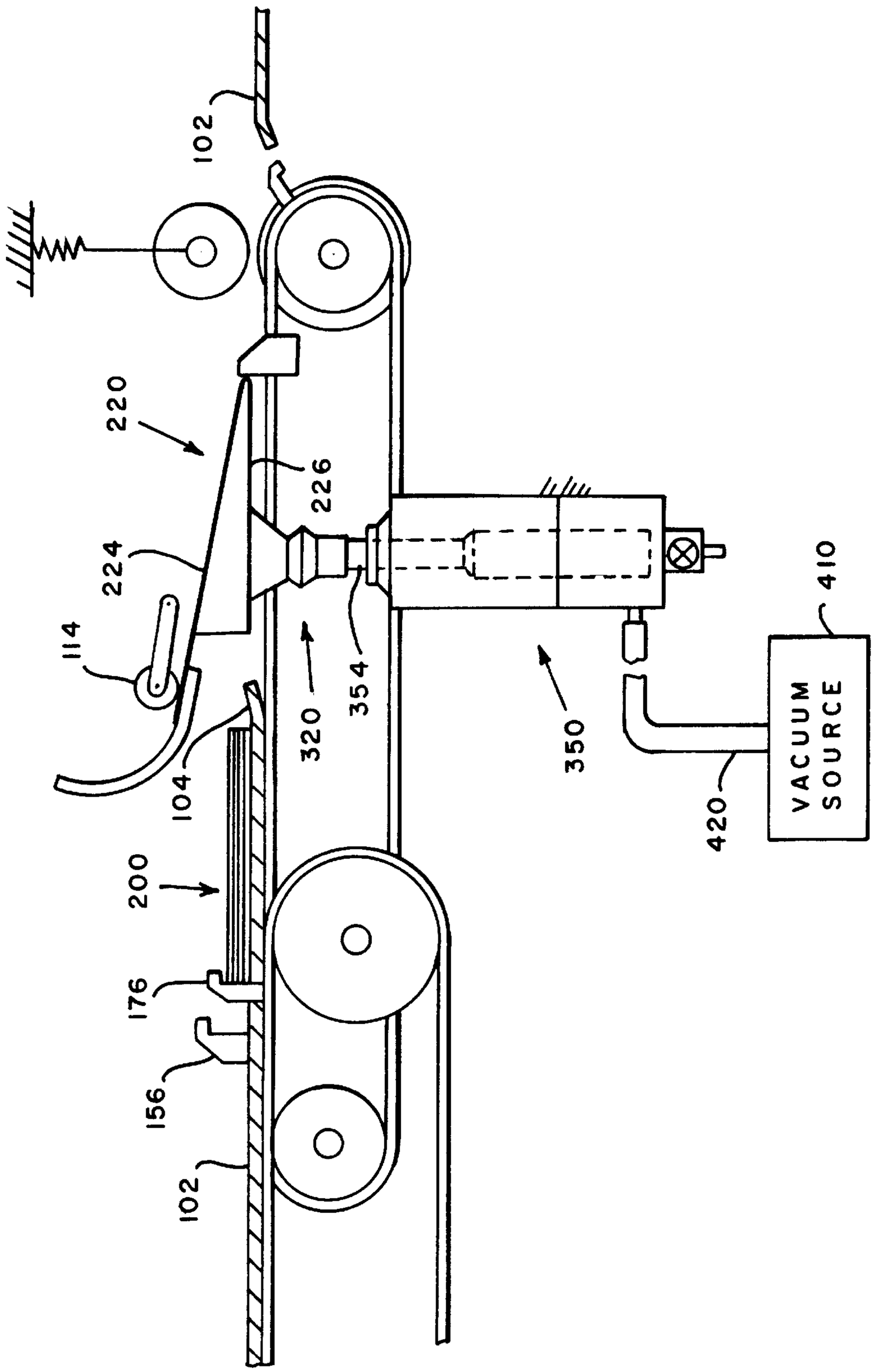

102
220
226
224
114
320
354
104
200
176
156
102
350
410
VACUUM SOURCE
420

FIG. 3C

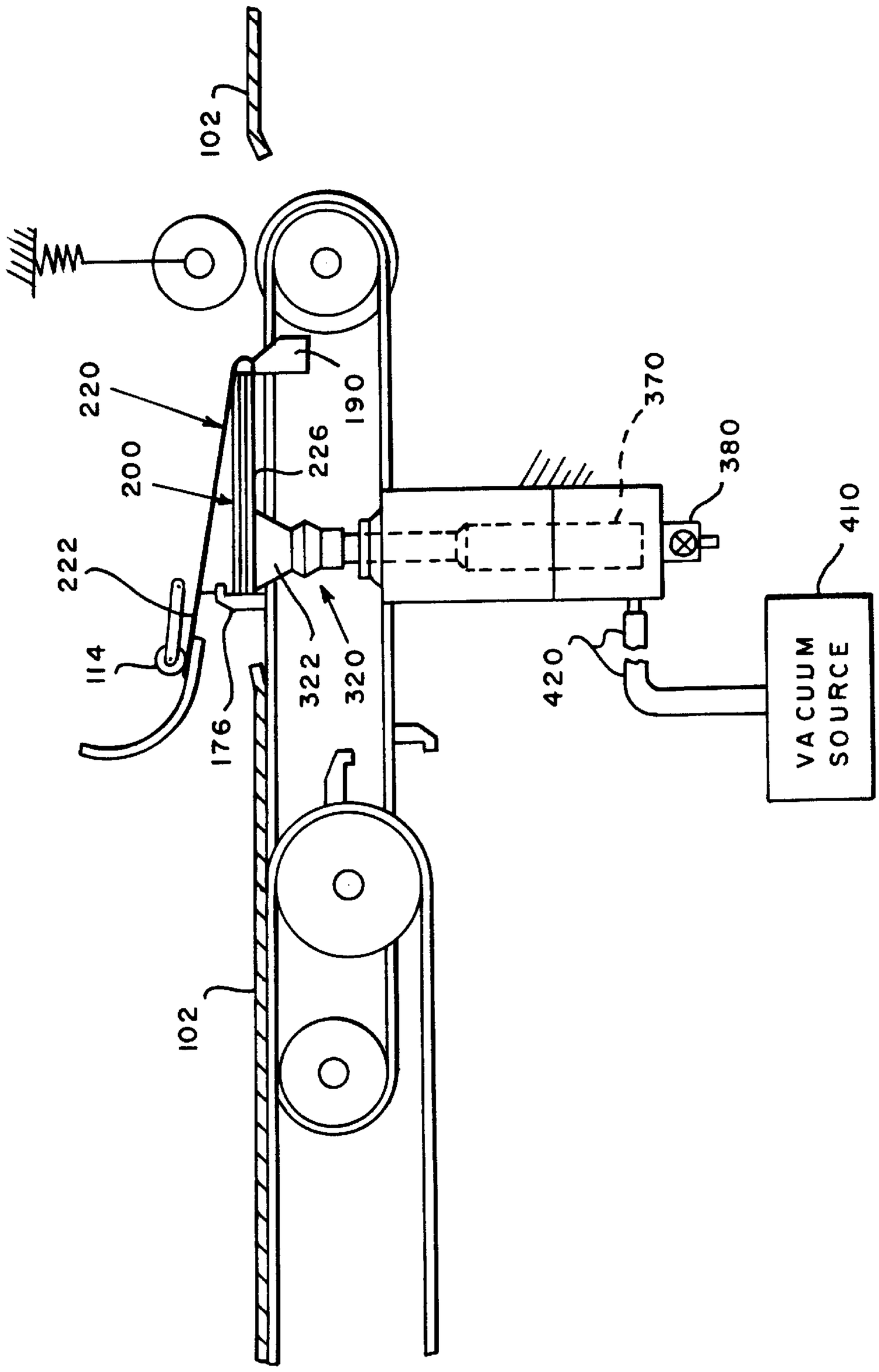

102
220
200
222
114
176
226
190
322
320
370
380
410
420
VACUUM SOURCE
102

FIG. 3D

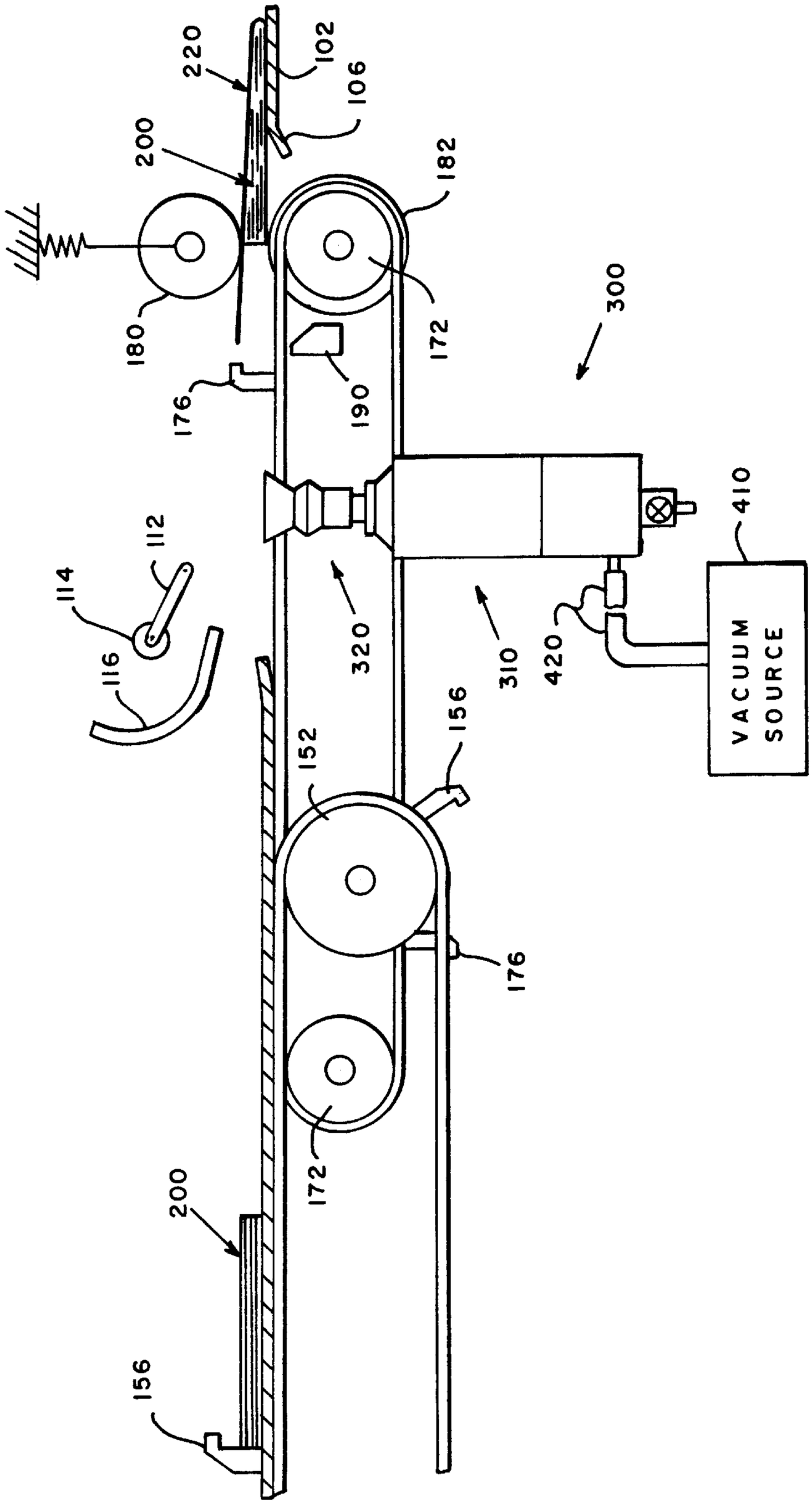

220
102
106
200
182
180
172
300
176
190
320
310
420
410
VACUUM SOURCE
114
112
116
152
156
176
172
200
156

FIG. 3E

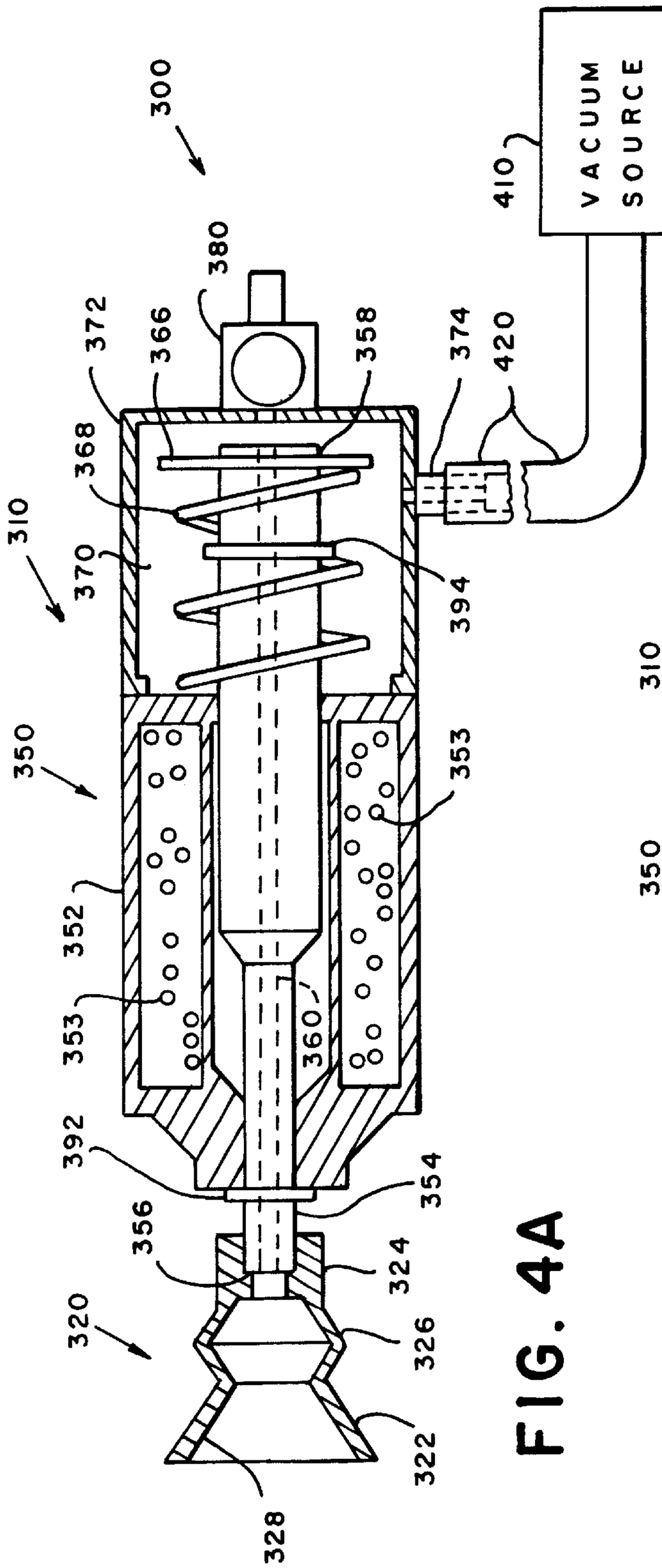

300
310
320
350
352
353
354
356
358
360
366
368
370
372
374
380
392
394
410
420
VACUUM SOURCE
324
326
328

FIG. 4A

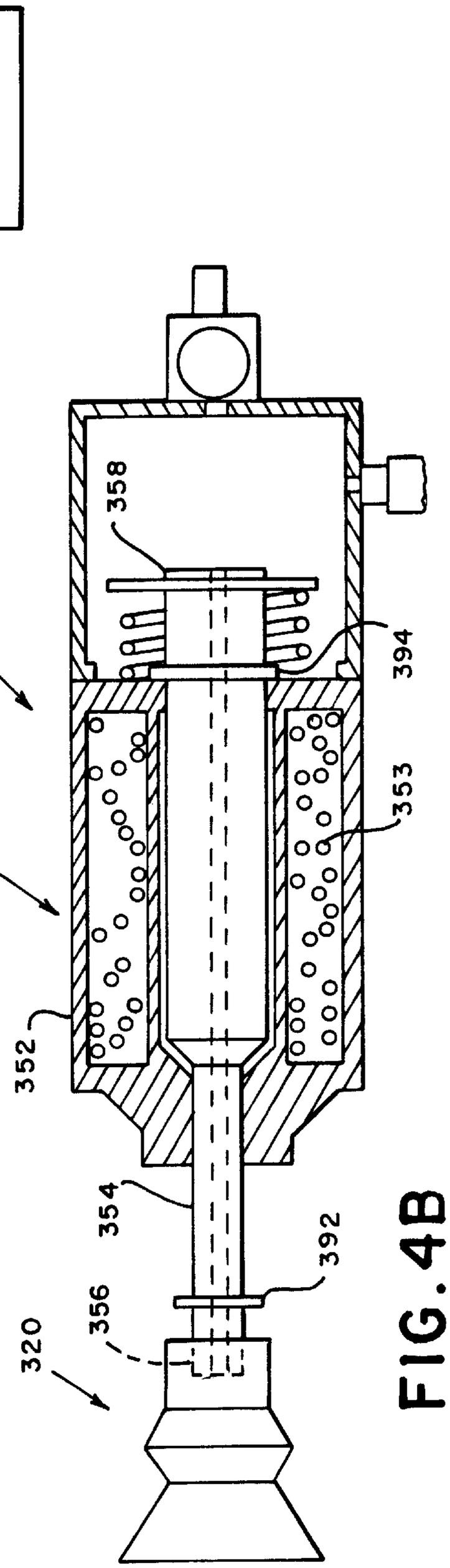

310
320
350
352
353
354
356
358
392
394

FIG. 4B

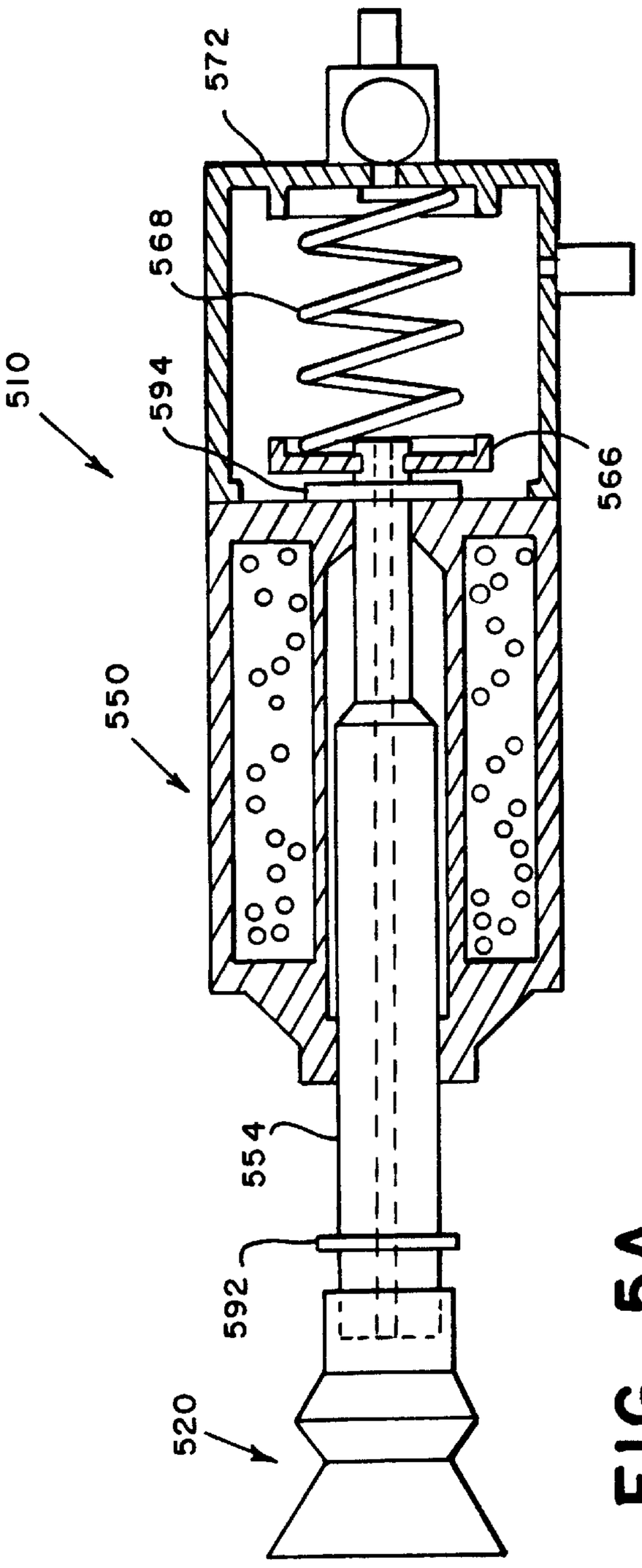

572
568
510
594
566
550
554
592
520

FIG. 5A

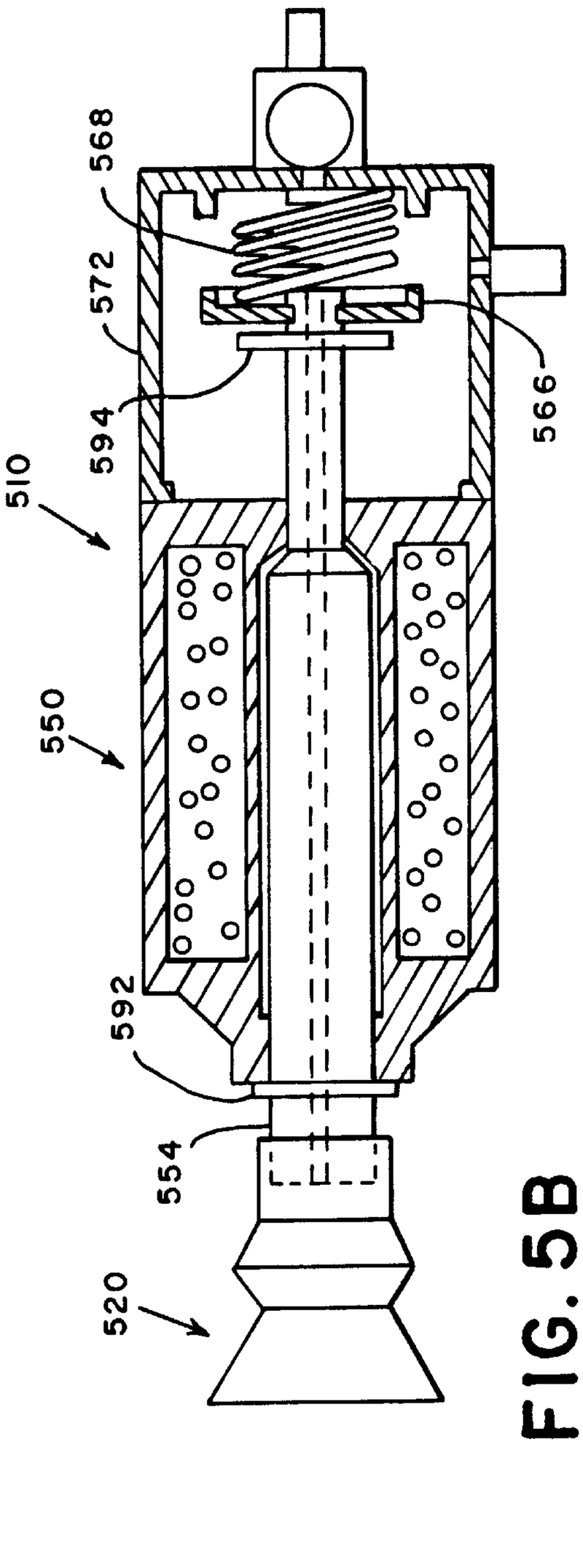

568
572
566
510
594
550
592
554
520

FIG. 5B

# SOLENOID APPARATUS HAVING A PLUNGER WITH AN INTERNAL PASSAGE AND A VACUUM SOURCE FOR GENERATING NEGATIVE PRESSURE

## CROSS REFERENCE TO RELATED APPLICATION

This application is an Divisional of U.S. patent application Ser. No. 08/498,007 filed on Jul. 3, 1995 and issued as U.S. Pat. No. 5,581,972.

## FIELD OF THE INVENTION

This invention relates to container opening apparatus, and more particularly, to an apparatus for opening an envelope.

## BACKGROUND OF THE INVENTION

A variety of containers exist that are individually suited to packaging, holding, shipping and storing a great many different types of contents. For example, an envelope is a special type of container used to store and ship enclosures (business letters, invoices, photographs, advertisements, etc.). Another example is a paper carton that is used to store a given number of packages of cigarettes. Still other examples are video and audio tape boxes which are used to store and ship tapes. Thus, it is apparent that there is a great diversity in the types, shapes and sizes of containers. Typically, the containers are made from a plurality of panels which are arranged to encompass a desired volume of space having a desired configuration. To gain access to the inside of the container it is necessary for at least one panel to be moveable with respect to the remaining panels. This is usually accomplished by a hinge arrangement where the moveable panel is connected to an adjacent panel along one edge. However, other arrangements are commonly used depending upon the application.

Often times, in placing contents into containers or in taking contents out of containers, there is a need for automatic equipment. Typically, cigarette manufacturers, tape manufacturers and high volume mailers utilize a great deal of automation to reduce costs and speed production. Necessarily then, the container must be opened before any later tasks can be performed. As a result of this need, a great many different types of container opening systems have been developed. Outlined below is a description of some of the container opening systems that are known in the art. Although most of the systems are from the envelope opening art, the concepts and underlying technology are similar and adaptable to those found in other disciplines using different containers.

Envelope handling machines are well known in the art. Typical types of envelope handling machines include: mailing machines, inserters, sorters and incoming mail handling machines. Frequently, these machines have the need to open an envelope so that a desired task or operation can be performed. For example, in an inserter it is necessary to open the envelope so that an enclosure can be fed into the envelope. Another example is in incoming mail handling machines where it is necessary to open the envelope so that the enclosures (possibly placed into the envelope by an inserter) can be removed from the envelope.

Many different systems exist to open envelopes and containers. Early systems were mechanical in nature and relied upon arms or fingers to reach inside the envelope in order to open it. Examples of such systems are shown in U.S. Pat. Nos. 4,337,609, 5,255,498, 5,191,751, and 5,247,780 all



of which are assigned to the assignee of the present invention. Although many improvements have been made over the years and such systems are generally effective, they still suffer from certain drawbacks. First, the envelopes are susceptible to damage by the moving parts of the system. Despite efforts to the contrary, inevitably envelopes are still torn or crushed by such systems. Second, because such mechanical systems are sensitive to wear, they need frequent recalibration and/or preventive maintenance.

Still other systems use a combination of vacuum and mechanical technologies to open envelopes and other containers. Examples of such systems are shown in U.S. Pat. Nos. 4,486,013, 4,776,152, and 5,052,168. In these systems, moveable sucker feet are brought into and out of engagement with the container by means of any suitable mechanical device. Additionally, the sucker feet are directly connected by tubes to a vacuum source in order to create the vacuum necessary to grab the envelope. Although these systems have less physical contact with the envelope than the pure mechanical systems, they too suffer from drawbacks. First, because the vacuum tubes are carried along with the sucker feet, they are in constant motion. In high throughput operations where the container opening apparatus performs many thousands of cycles per hour, there is a risk that the vacuum tube will shake itself loose from the sucker foot. Second, the vacuum tube is susceptible to wear as it rubs up against adjacent components cycle after cycle. In an extreme case, the vacuum tube may even become tangled. All of these problems result in a loss of vacuum at the sucker foot where it is needed and require operator intervention to correct.

Accordingly, there is a need for a container opening apparatus that provides reliable operation without the risk of damage to the container, risk of loss of vacuum or frequent maintenance.

## SUMMARY OF THE INVENTION

The present invention contemplates an apparatus for opening a container including at least one moveable panel. The apparatus comprising a frame, vacuum source means, means for gripping the container and a solenoid fixably mounted to the frame. The solenoid including a moveable plunger having a first end and an internal passage having an opening at the first end and being in communication with the vacuum source means. The gripping means mounted to the plunger first end. Also, the apparatus additionally including control means for actuating the plunger between a home position where the gripping means is spaced apart from the moveable panel and an operative position where the gripping means contacts the moveable panel. The vacuum source means for applying negative pressure to the internal passage so that the moveable panel adheres to the gripping means as the plunger moves from the operative position to the home position separating the moveable panel from the container and opening the container.

Therefore, it is now apparent that the invention achieves all the above objects and advantages. Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate a pres-

ently preferred embodiment of the invention, and together with the general description given above and the detailed description of the preferred embodiment given below, serve to explain the principles of the invention. As shown throughout the drawings, like reference numerals designate like or corresponding parts.

FIG. **1** is a perspective view of a prior art console inserter in which the present invention may be employed.

FIG. **2** is a top plan view of a container opening apparatus in accordance with the present invention.

FIGS. **3**A through **3**E are side elevational views of the apparatus representing different stages in one cycle of the operation of the apparatus.

FIG. **4**A is a partial sectional and partial break-away view of a modified push type linear solenoid as employed in the apparatus in a de-energized state.

FIG. **4**B is a partial sectional and partial break-away view of a modified push type linear solenoid as employed in the apparatus in an energized state.

FIG. **5**A is a partial sectional and partial break-away view of a modified pull type linear solenoid that could alternatively be employed in the apparatus in a de-energized state.

FIG. **5**B is a partial sectional and partial break-away view of a modified pull type linear solenoid that could alternatively be employed in the apparatus in an energized state.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In describing the preferred embodiment of the present invention, reference is made to FIG. **1** wherein a prior art console inserter **20** in which the present invention may be employed is shown. Although the description to follow is provided with respect to a container opening apparatus used to open envelopes in the inserter **20**, those skilled in the art will recognize other applications for the same apparatus.

The console inserter **20** includes a plurality of serially arranged modules including envelope feeder/insert station **22** and enclosure feeder stations **24**, **26**, **28**, **30** and **32** and burster/folder station **34**. A web form feeder **36** feeds a computer generated continuous web **38** of control documents **40** having coded markings **42** thereon. The burster/folder **34** separates the web **38** into individual documents **40** and then folds the documents **40**. Additionally, as the documents **40** are fed through the burster/folder **34**, the control markings **42** are sensed by control scanner **50**. Thereafter, the documents **40** are fed downstream where feeder stations **24**, **26**, **28**, **30** and **32** selectively and sequentially feed the necessary enclosures to the transport path according to the instructions contained within the control markings **42** of each document **40**. Thus, a collated stack consisting of the document **40** and respective enclosures is delivered to the station **22** where the stack is inserted into an envelope. Then, the envelope is fed downstream where other additional operations are performed. A detailed description of the inserter **20** is found in U.S. Pat. No. 4,547,856, incorporated herein by reference.

Referring to FIGS. **2** and **3**A, an insert station **100** is shown which includes an envelope feeder **110**, envelope stuffing apparatus and envelope opening apparatus **300**. The feeder **110** is only partially shown. The insert station **100** includes suitable framework, not shown, for mounting and supporting the various components of the feeder **110**, stuffing apparatus and opening apparatus **300**.

A stack **200**, including the folded control document **40** and a plurality of enclosures **202** supplied by the feeder stations **24**, **26**, **28**, **30** and **32**, is fed along a deck **102** in a downstream path of travel as indicated by arrow A through the insert station **100**. To feed the stack **200** along the deck **102** and into an empty envelope **220** pusher assemblies **150** and **170** operate successively on the stack **200**. Each pusher assembly **150** and **170** includes a respective pair of sub-assemblies that are laterally aligned so as to act in parallel and in cooperation to feed the stack **200**. For each pusher assembly **150** and **170**, a description is provided with respect to one of the pairs of sub-assemblies since the other is substantially identical.

The pusher assembly **150** is located at the input end of insert station **100** and adjacent to the output end of the enclosure feeder **24**. The pusher assembly **150** includes a pair of pushers **156** attached to an endless chain **154** which is mounted on a pair of sprockets **152** (only one is shown). As the sprockets **152** rotate causing the chain **154** to advance, the pushers **156** alternatively rise above and fall below the deck **102** which contains suitable openings so as not to interfere with the pushers **156**. The pushers **156** feed the stack **200** at a known speed dependent on the upon the rotational speed on the sprockets **152** which are under the control of a drive mechanism (not shown).

The pusher assembly **170** is located downstream from the pusher assembly **150**. The pusher assembly **170** includes a pair of pushers **176** attached to an endless chain **174** which is mounted on a pair of sprockets **172**. As the sprockets **172** rotate causing the chain **174** to advance, the pushers **176** alternatively rise above and fall below the deck **102** which contains suitable openings so as not to interfere with the pushers **176**. The pushers **176** feed the stack **200** at a known speed which is approximately one and a half (1.5) times the speed of pusher **156**.

The pusher assemblies **150** and **170** overlap so that in operation the stack **200** can be transferred from assembly **150** to assembly **170**. It should now be understood that the spacing of the pushers **156** and **176** along chains **154** and **174**, respectively, is coordinated so that pushers **176** overtake pushers **156** shortly after pushers **156** deliver the stack **200** into the overlap area. Thus, the stack **200** has been taken away from the pushers **156** by the faster pushers **176** before the pushers **156** pass beneath the deck **102** and reposition for another cycle. It should also be understood, that any other suitable mechanism, a belt for example, could be used to drive the pushers **156** and **176**.

Envelopes **220** are fed from the envelope feeder **110** to an insert position where the stack **200** is inserted into the envelope **220**. In the preferred embodiment of the present invention, the envelope **220** rests in the insert position on a pair of adjustable guides **240** which may be repositioned in a direction transverse to the path of travel A so that different size envelopes **220** may be accommodated. The guides **240** each include a shelf portion **242** for supporting the edges of the envelope **220**. The shelf portions **242** are at a slight angle from horizontal so as to deliver the envelope **220** into the path of travel. An example of an envelope feeder **110** which can be used in conjunction with the present invention is described in U.S. Pat. No. 4,775,140 which is incorporated herein by reference.

A pair of stops **190** rise above and fall below the deck **102** and shelf portion **242** as necessary to stop and register the envelope **220** in the insert position. Any one of numerous mechanisms would be suitable for raising and lowering the stops **190**. While seated against the stops **190** and resting on the shelf portions **242**, the envelope flap **222** which is in an open position is supported by ledge **116**. A plurality of

depressor fingers **112**, each including a roller **114**, apply pressure to the envelope flap **222** holding it against the ledge **116**. Additionally, the depressor fingers **112** provide stability to the envelope **220** during opening and insertion of the stack **200** (described below). In the alternative, a pressure plate or other suitable apparatus may be employed to hold down the flap **222**.

Referring to FIGS. **2**, **3**A, **4**A and **4**B, with the envelope **220** in the insert position, it is necessary to open the envelope **220** prior to insertion of the stack **200**. The envelope body includes a front panel **224** and a back panel **226**. Generally, the front panel **224** is where the destination address and postal information appear. The envelope flap **222** is typically connected to the front panel **224** along the top edge of the envelope **220**. Positioned adjacent to the back panel **226** of the envelope **220** is an opening assembly **300** for separating the back panel **226** from the front panel **224**. The opening assembly **300** includes a pair of solenoid assemblies **310**, a vacuum source **410** and a hose **420** for connecting the solenoid assemblies **310** to the vacuum source **410**. The solenoid assemblies **310** and vacuum source **410** are is communication with a suitably designed microcontroller **450** which provides appropriate signals for energizing the solenoid assemblies **310** and activating the vacuum source **410**, respectively.

Referring to FIGS. **4**A and **4**B, each solenoid assembly **310** includes a sucker foot **320** and a linear solenoid **350**. It is important that the sucker foot **320** is made from a suitably flexible material with a high coefficient of friction. The linear solenoid **350** includes a generally cylindrical casing or housing **352**, a plunger **354** slideably mounted to the housing **352** and a wire coil **353** for inducing a magnetic force on the plunger **354** causing it to move between an extended and a retracted position. The plunger **354** is generally rod shaped and has a first end **356** with which some task is to be performed and a second end **358**. Running the length of the plunger **354** from the first end **356** to the second end **358** is a hole **360**. The sucker foot **320** includes a suction end **322**, a flange end **324**, a flexible portion **326** disposed between the suction end **322** and the flange end **324** and an opening **328** running from the suction end **322** to the flange end **324**. The sucker foot **320** is attached to the plunger **354** by slipping the flange end **324** over the first end **356**.

The solenoid **350** is a push type solenoid; meaning that it operates in only one direction. FIG. **4**A shows the plunger **354** in a retracted position in a de-energized state. This position is also referred to as a home position. When the coil **353** is energized, as shown in FIG. **4**B, the resulting magnetic force on the plunger **354** causes the plunger first end **356** to extend or move away from the plunger housing **352** to an extended or operative position. Since the solenoid **350** is oriented vertically with the first end **356** pointing up, gravity will return the plunger **354** to the retracted position once the coil **353** is de-energized. In some slow speed and low friction operations, a gravity return may be sufficient. However, in a high speed operation with the added complications of increased friction due to paper dust and other contaminants as in the present invention, a quicker more dependable return mechanism is needed.

Therefore, to overcome friction and any residual magnetism a spring assembly is used to return the plunger **354** to the home position once the solenoid **350** has been deactivated. Thus, each solenoid assembly **310** includes a clip **366** mounted to the plunger **354**, preferably at the second end **358**, and a compression spring **368** axially positioned along the plunger **354** to extend between the clip **366** and the housing **352**. The spring **368** should be assembled so that it has a slight pre-load, compression, in the retracted position. The clip **366** and spring **368** arrangement serve to bias the plunger **354** in the home position. Thus, energizing and de-energizing the coil **353** controls the position of the plunger **354** by providing sufficient magnetic force on the plunger **354** to overcome the spring bias.

For limiting the stroke of the plunger **354**, each solenoid assembly **310** includes a pair of stops **392** and **394**. Stop **392** is mounted near the plunger first end **356**. As shown in FIG. **4**A, the stop **392** rests against the housing **352** to prevent further travel of the plunger **354** due to the spring bias. As shown in FIGS. **4**B, the stop **394** is mounted near the plunger second end **358** and rests against the housing **352** to prevent further travel of the plunger **354** due to the magnetic force induced by the solenoid **350**.

Also included in each solenoid assembly **310** is a generally hollow housing **372** which is hermetically mounted to the solenoid housing **352** adjacent to the second end **358** of the plunger **354**. Thus, the housing **372** creates a chamber **370** within which the second end **358** of the plunger **354** moves. The housing **372** includes a port **374** which serves as an inlet to chamber **370** and is connected to the vacuum source **410** via hose **420**. Therefore, it should now be apparent that when the vacuum source **410** is activated, the air in the chamber **370** is evacuated and the resulting negative air pressure is translated along the plunger hole **360** and through the sucker foot **320**. Thus, the hole **360** functions as an internal passage to the plunger **354** to carry the negative pressure from the chamber **370** to the sucker foot **320**. Additionally, mounted to the housing **372** is an air flow control valve **380** which is adjustable to allow a small amount of air to leak into the chamber **370** while the vacuum source **410** is activated. Thus, valve **380** provides a connection from the inner chamber **370** to the outside environment. Valve **380** is of a type commonly available from numerous suppliers, such as Versa Products Company, Inc. of Paramus, N.J. It is important that the vacuum source **410** when activated is sufficiently powerful to create negative pressure regardless of the air leaking into the chamber **370** from the valve **380**. The benefits of this arrangement will be discussed below.

In a more simplified embodiment, the solenoid assembly **310** is reconfigured so that the sucker foot **320** does not have a flexible portion but merely a suction end and a flange end. Also, it is possible to fit the hose **420** directly onto the plunger second end **358** and thus eliminate the housing **372**, chamber **370**, port **374** and valve **380**.

In an alternative embodiment, a pull type solenoid could be used. Referring to FIGS. **5**A and **5**B, a solenoid assembly **510** using a pull type solenoid **550** is shown. As discussed above for the solenoid assembly **310**, each solenoid assembly **510** includes a sucker foot **520** and a housing **572**. These features remain substantially similar to their respective counterparts discussed above and require additional explanation.

However, since the solenoid **550** is a pull type solenoid some minor modifications need to be made. FIG. **5**A shows the plunger **554** in an extended or active position in a de-energized state. Spring **568** has been repositioned to bear against the housing **572** and clip **566** so as to bias the plunger **554** in the active position. Stop **594** prevents further travel of the plunger **554**. FIG. **5**B shows the plunger **554** in a home or retracted position in an energized state. Thus, the magnetic force on the plunger **554** has overcome the spring bias to compress the spring **568**. Stop **592** prevents further travel of the plunger in this condition. The remaining characteris-

tics of assembly **510** are substantially similar to those of assembly **310** are thus require no further discussion beyond that already provided and what is inherent from FIGS. **5**A and **5**B.

Those skilled in the art will appreciate that the movement of the pushers **156** and **176**, feeding of the envelope **220**, raising of the stops **190** and activation of the opening assembly **300** are appropriately timed to ensure proper operation. The following description is provided with reference to FIGS. **3**A–**3**E to summarize the operation of one cycle in the insert station **100**.

Referring to FIGS. **2** and **3**A, the stack **200** is being pusher by the pushers **156** downstream towards the insert area. A pair of adjustable guides **270** having horizontal portions **272** assist in registering the stack **200** prior to insertion and preventing the stack **200** from becoming skewed. The guides **270** may be repositioned in a direction transverse to the path of travel A so that different size stacks **200** may be accommodated. The stack guides **270** are thus positioned slightly inboard from envelope guides **240**. Simultaneously, the stops **190** are raised and the envelope **220** is fed from the envelope feeder **110** until it encounters the stops **190**. In this position, the envelope **220** is resting against the stops **190** and supported by the shelf portion **242** of guides **240**. Additionally, the envelope flap **222** is pressed against the ledge **116** by the rollers **114** because the fingers **112** are in the down position. Thus, the envelope **220** is stationary and stabilized. Additionally, the solenoid plunger **354** is not energized and shown in the home or retracted position.

Referring to FIG. **3**B, the pushers **176**, which are traveling 1.5 times faster than pushers **156**, take over delivery of the stack **200** before the pushers **156** recess below the deck **102**. Simultaneously, the vacuum source **410**, which may be of a conventional vacuum pump design, is activated. It is important that the vacuum source **410** is sufficient to overcome the leakage due to the valve **380**. In this way, a negative pressure is created in the chamber **370** and at the sucker foot suction end **322** via the passage **360**. Next, the solenoid **350** is energized causing the plunger **354** to move to the extended or operative position where the sucker foot suction end **322** contacts the envelope back panel **226**. Because the suction foot **320** is made from a flexible material, such as rubber, it conforms to the shape of the back panel **226**. Due to the negative pressure, the back panel **226** is drawn against and adheres to the suction end **322**. It is important to note that the distance from suction end **322** in the retracted position to the back panel **226** is selected so that the stroke of the plunger **354** will ensure that the suction end **322** contacts the back panel **226** in the extended position. Additionally, this distance is selected so that the flexible portion **326** of the sucker foot **320** compresses slightly due to the contact with the back panel **226**. In this manner, the apparatus is more tolerant of variances in manufacture and envelope thicknesses. Furthermore, the compression of the flexible portion **326** reduces the impact force on the envelope **220**.

Referring to FIGS. **2** and **3**C, the solenoid **350** has been de-energized and the spring **368** returns the plunger **354** to the retracted position. However, the vacuum source **410** remains activated. Because of the negative pressure, flexibility of the sucker foot **320** and the high coefficient of friction, the back panel **226** and the sucker foot **320** remain in intimate contact. Thus, as the plunger **354** and sucker foot **320** retreat, the envelope back panel **226** stays adhered to the suction end **322** and separates from the opposing front panel **224** which is held in a fixed position by the rollers **114** and guide shelf portion **242**. The envelope **220** is now ready to accept the stack **200** as the pushers **176** advance. Furthermore, the deck **102** includes a ramp portion **104** to prevent the stack **200** from crashing into the edge of the back panel **226** as the stack **200** is fed into the envelope **220**.

Referring to FIG. **3**D, the stops **190** have descended below the deck **102** as the stack **200** is fed completely into the envelope **220**. The rollers **114** remain in the down position to provide resistance to the movement of the envelope **220**. This ensures that the stack **200** is properly seated in the envelope **220** before the pushers **176** supply enough force to overcome the hold down force of the rollers **114** on the envelope flap **222** so as to feed the envelope **220** downstream. At this point, the vacuum source **410** is de-activated and air leaks into the chamber **370** due to the pressure gradient via the valve **380** so as to dissipate the negative pressure which has been built up. Air leaks into the chamber **370** until the pressure inside the chamber **370** reaches ambient conditions. Thus, the valve **380** ensures that no residual negative pressure remains which would cause the back panel **226** to remain adhered to the sucker foot **320** after the vacuum source **410** has been de-activated. Also, this ensures that the suction end **322** quickly releases the back panel **226** and no skewing or misalignment of the envelope **220** occurs during feeding.

Referring to FIGS. **2** and **3**E, the pushers **176** continue to feed the envelope **220**, with the stack **200** properly seated inside, downstream toward the take-away rollers **180** and **182**. The deck **102** contains a ramp portion **106** to assist feeding the envelope from guide shelf portions **242** back onto the deck **102**. The fingers **112** are now shown in an up position where the rollers **114** are spaced apart from the ledge **116**. Therefore, no further hold down pressure is provided. Finally, the rollers **180** and **182** feed the envelope **220** downstream before the pushers **176** recess below the deck **102**. Once cycle is now complete.

Those skilled in the art will now recognized the advantages of the present invention over the prior art. For example, the hose **420** is located away from the sucker foot **320** and remains stationary during the entire operation of the opening apparatus **100**. This reduces wear and the risk of the tube shaking loose from its connections to the vacuum source **410** and the port **374**. Also, it keeps the hose **420** away from the path of travel where it could interfere with the envelope **220** or become tangled with other moving parts. Since the only moving parts are the plunger **350** and sucker foot **320**, ease of manufacture and reduction in part count are both achieved. All these benefits have the net effect of a more reliable opening apparatus requiring less operator intervention.

Many of the design details of the present invention have alternatives that would be obvious to those skilled in the art. For example, an envelope feeder could be designed to deliver envelopes with the back panel facing up. This might necessitate that the opening apparatus be relocated to a position above the deck. Alternatively, the opening apparatus may be employed against the front panel of the envelope while the back panel of the envelope is retained. Thus, the container need only have one moveable panel for the opening apparatus to act upon.

Additionally, other stack feeding apparatus are well known in the art that could effectively replace the pushers used in the present invention while the exact means used to retain and support the envelope during opening are not particular to practicing the invention. Furthermore, it is possible to substitute a rotary solenoid, linear motor or other electro-magnetically actuated device for the linear solenoid described above. Only small modifications in design detail

would be necessary to accomplish this. Those skilled in the art will obviously be capable of deducing still further substitutions.

Moreover, those skilled in the art will find other uses for the solenoid **350**. For example, the solenoid **350** may be utilized to deliver: air, water, glue, paint, wax, and so forth to a work area. By connecting the solenoid **350** to an external device, bedsides a vacuum source as described in the preferred embodiment, a wide variety of additional uses become available.

Many features of the preferred embodiment represent design choices selected to best exploit the inventive concept as implemented in an envelope opening apparatus as used in an inserter. Those skilled in the art will recognize that the present invention is appropriate for other applications as discussed above in the "Background of the Invention" with only minor modifications to the preferred embodiment. Accordingly, various modifications may be made without departing from the spirit of the general inventive concept. Therefore, the invention in its broader aspects is not limited to the specific details of the preferred embodiment but is defined by the appended claims and their equivalents.

What is claimed is:

**1**. A solenoid apparatus comprising:

a substantially cylindrical casing,

a plunger axially aligned and slideably mounted to said causing, said plunger having first end extending outside of said casing, a second end and an internal passage extending from said first end to said second end,

electro-magnetic means which is selectively energizeable for moving said plunger between a first position and a second position,

a housing hermetically mounted to an end of said casing corresponding to said plunger second end to define an inner chamber which encloses said plunger second end, said housing including an external port connected to said inner chamber so as to provide an unobstructed pathway from said external port to said first end of said plunger via said internal passage and said inner chamber regardless of whether said plunger is in said first position, said second position or therebetween, and

vacuum means operatively coupled to said external port and selectively activatable for generating negative pressure at said first end of said plunger.

**2**. The solenoid apparatus of claim **1** further comprising:

vent means mounted to said housing for allowing ambient air to leak into said inner chamber so as to dissipate said negative pressure generated by said vacuum means when said vacuum means is not activated.

**3**. The solenoid apparatus of claim **2** wherein:

said vent means includes an adjustable valve for regulating a rate at which said ambient air leaks into said inner chamber.

**4**. The solenoid apparatus of claim **3** wherein:

when said vacuum means is activated said resulting negative pressure generated within said inner chamber is sufficient to overcome said rate at which said ambient air leaks into said inner chamber so that negative pressure results at said first end of said plunger.

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